Exclusive diffractive Higgs and Jet production at the LHC in FPMC

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in collaboration with
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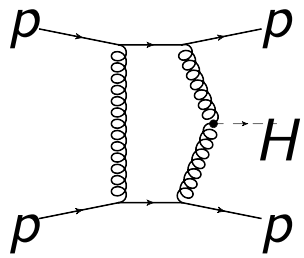
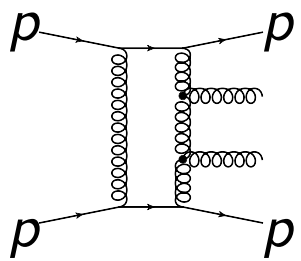
Outline

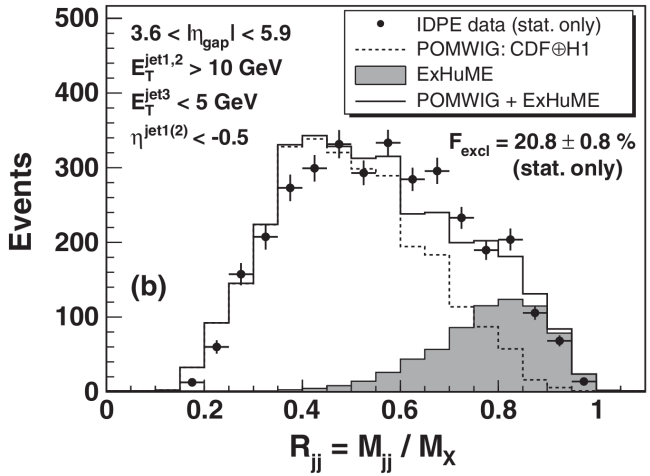
Exclusive production – introduction

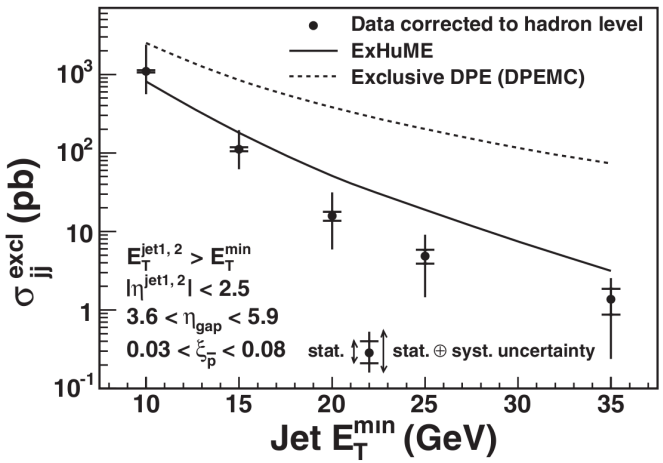
- Models
  1. **V.A. Khoze, A.D. Martin, M.G. Ryskin (KMR, Durham model)**
  2. **J.R. Cudell, A. Dechambre, O.F. Hernández, I. P. Ivanov (CHIDe, Liège model)**
  3. A. Szczurek *et al.* (Krakow model)
  4. A. Bialas, P.V. Landshoff
  5. M. Boonekamp, R. Peschanski, C. Royon





- CDF measurements (in this analysis only dijets measurement was used)





Forward physics at LHC

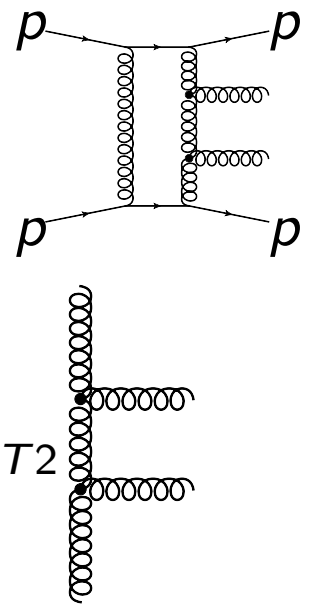
- Projects for forward physics in both ATLAS and CMS
- Proton taggers – on both sides
- 220m + 420m from IP
- Scattered proton fractional momentum loss ($\xi = \Delta p/p_0$) acceptance: $0.002 < \xi < 0.2$
- Central mass acceptance: 100 GeV $< M <$ 2 TeV
- Pixel detectors for scattered proton position and angle measurement
- GASTOF and QUARTIC – superfast timing detectors ($\sim$10 picosecond resolution – for pile-up background rejection)

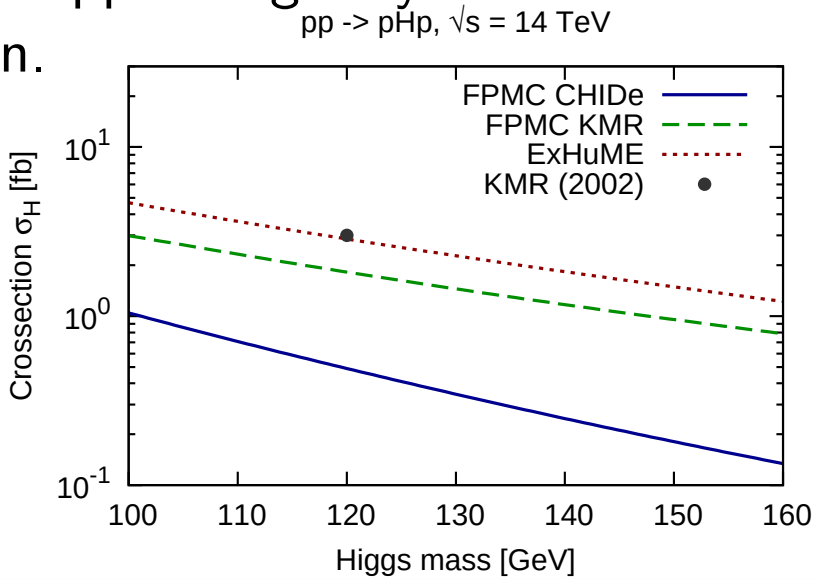
Forward Physics Monte Carlo (FPMC)

- Single Diffraction
- Double Pomeron Exchange
- Exclusive diffractive production
  - KMR (Khoze, Martin, Ryskin) – direct implementation (dijets, Higgs)
  - CHIDe (Cudell, Dechambre, Hernández, Ivanov) – the only MC implementation (gluon dijets, Higgs)
  - In preparation
    - diphoton, quark dijets in CHIDe model
    - Krakow model (Szczurek *at al.*)
- Photon-photon physics (including anomalous triple and quartic couplings between γ and W/Z)
- Hadronisation – Herwig
- Interface to AtlFast++
- Soon to be published

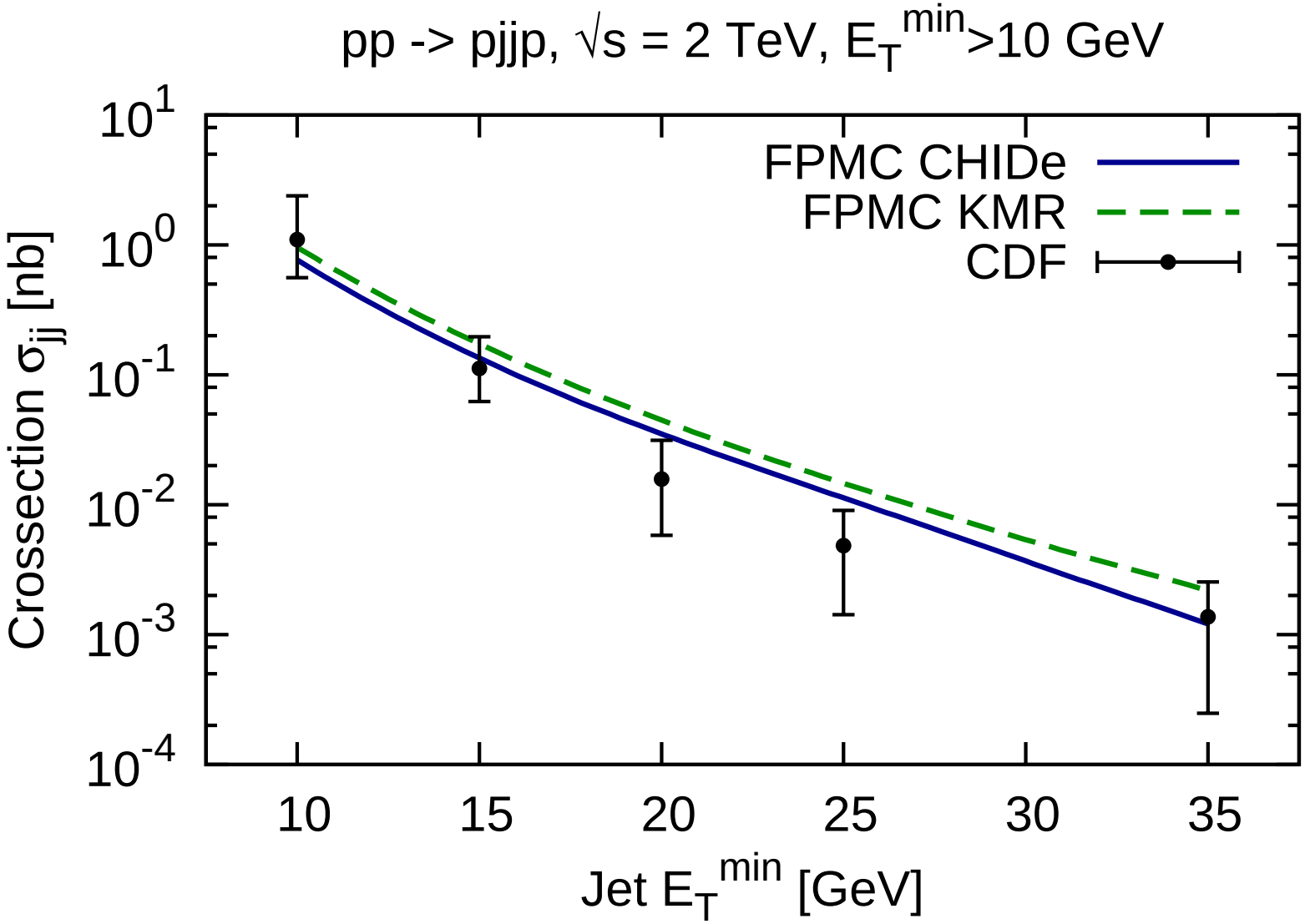
CHIDe model vs KMR model

1. Models are similar – basicaly the same ingredients, differences in details
2. Different upper limit in Sudakov factor (for jets)
   1. KMR: s_{gg} – gluon-gluon invariant mass
   2. CHIDe: k_{T2}
3. Exact kinematics in CHIDe (collinear for KMR)
4. Proton wavefunction included in CHIDe – in addition to Sudakov factor there is an impact factor, regulating divergence by suppressing very soft gluon emissions from proton.

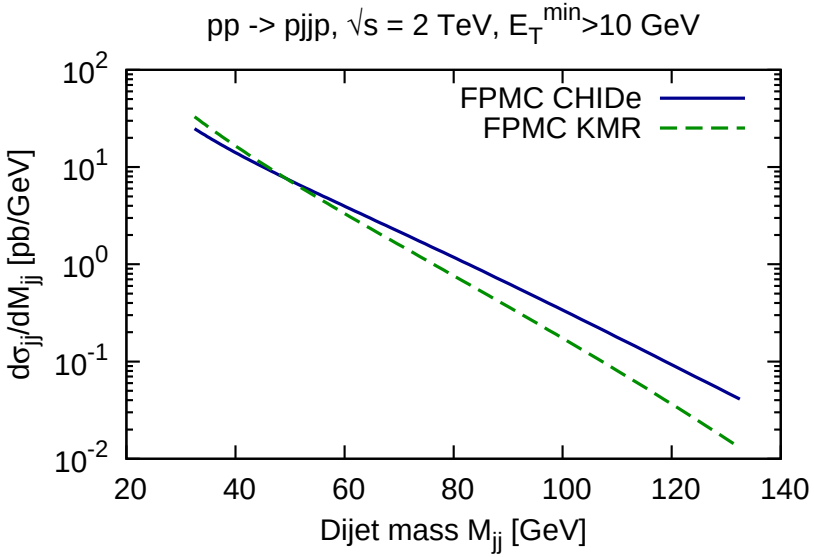


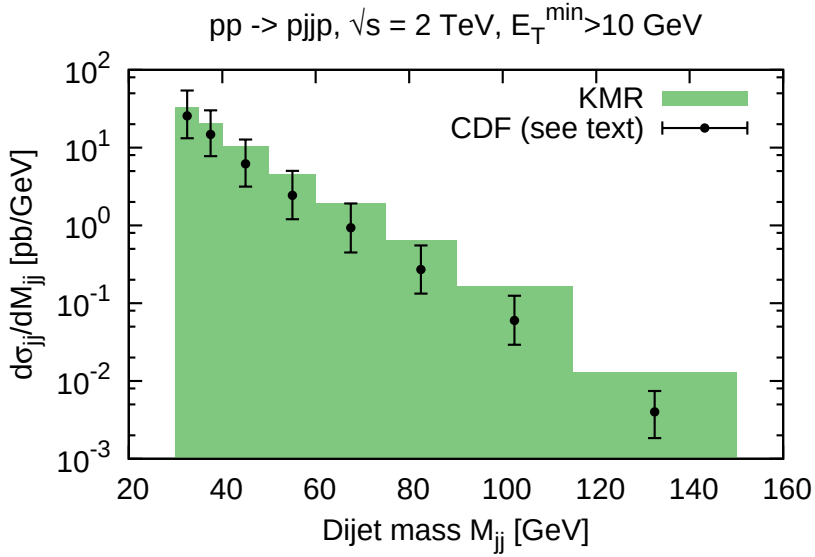


CDF measurement of exclusive dijets

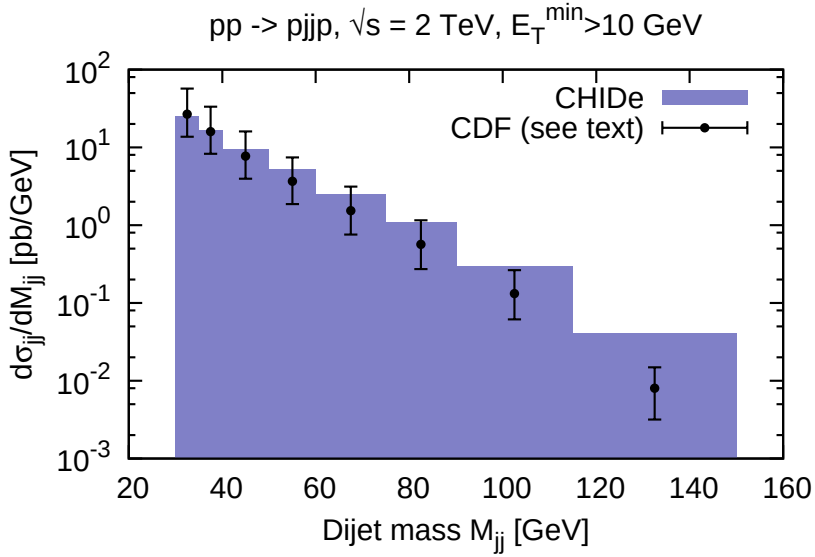


Dijet mass distributions





CDF prescription for extracting M_{JJ} distribution:
Reweight every MC event using the measured E_T^{min} distribution.



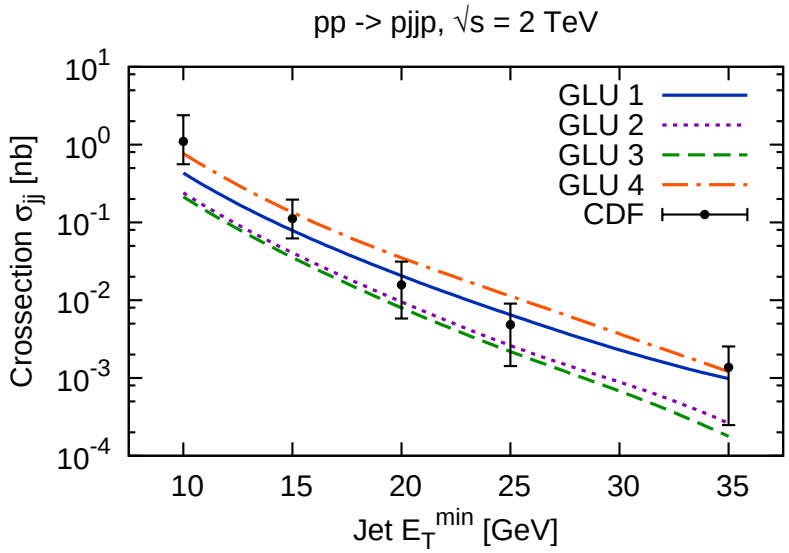
Uncertainties of the models

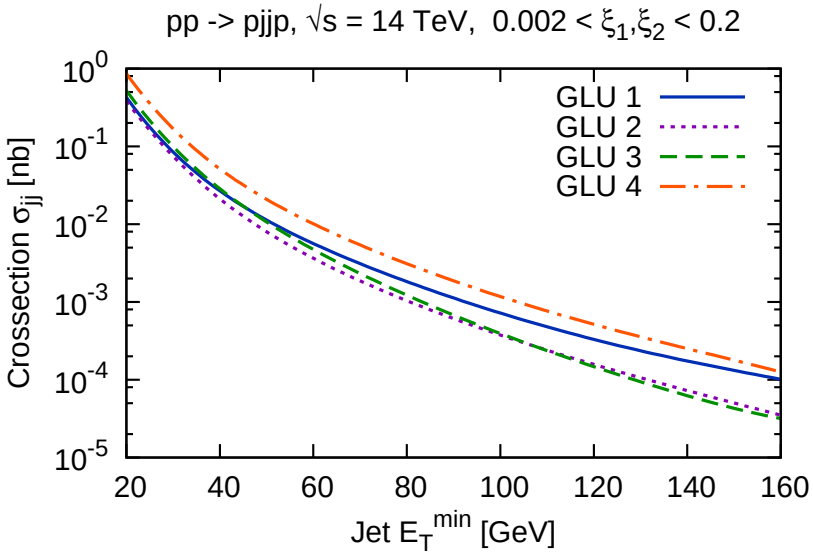
- Rapidity Gap Survival Probability (taken 0.1 at the Tevatron and 0.03 at the LHC)
- **Gluon densities**
- **Sudakov form factor**

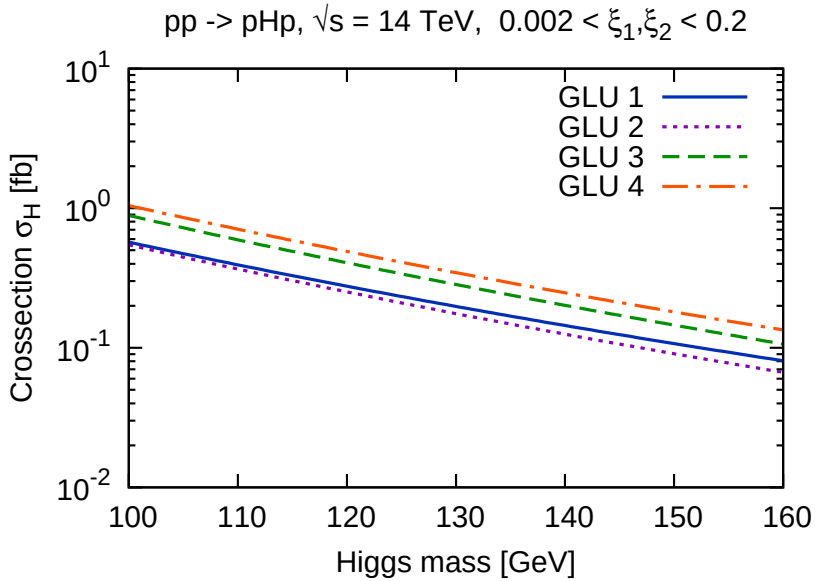
Studied in the CHIDe model.

Model uncertainties – gluon distribution

1. $G = G^{\text{hard}} + G^{\text{soft}}$
2. different soft contribution

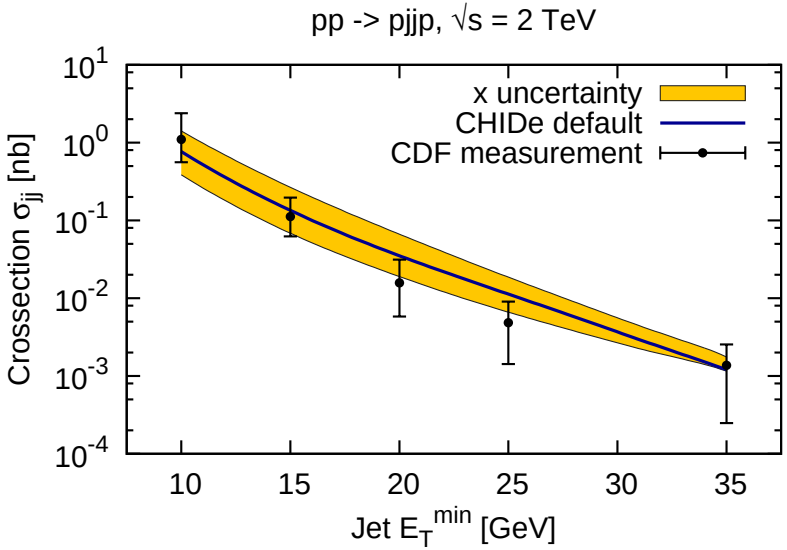


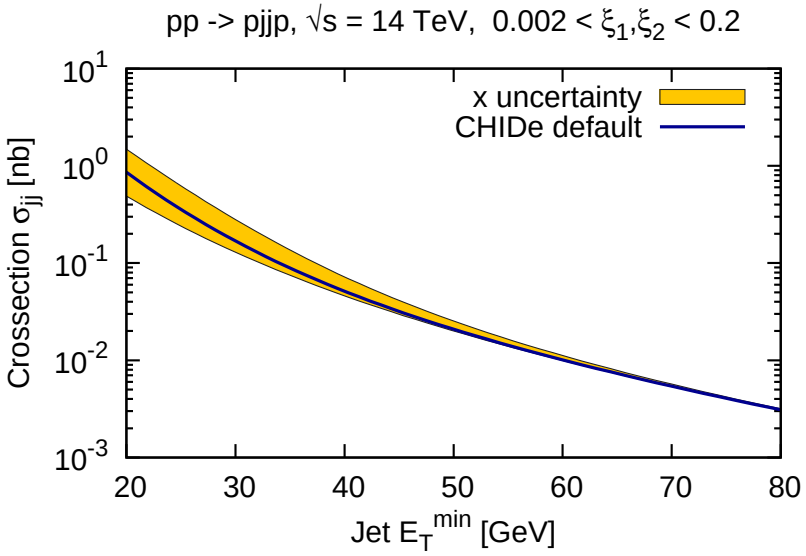




Model uncertainties – Sudakov factor upper limit (x)

$$T(Q_T,\mu) = \exp\left\{ - \int\limits_{Q_T^2/x'}^{\mu^2/x} \frac{\alpha_S(k_T^2)}{2\pi} \frac{\mathrm{d}k_T^2}{k_T^2} \int\limits_0^{1-\Delta} \mathrm{d}z \left(zP_{gg}(z) + \sum_q P_{qg}(z) \right) \right\}$$

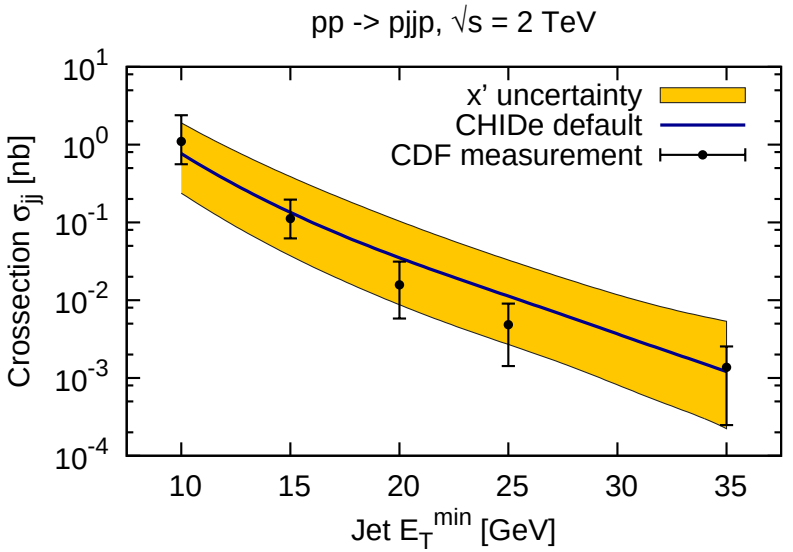


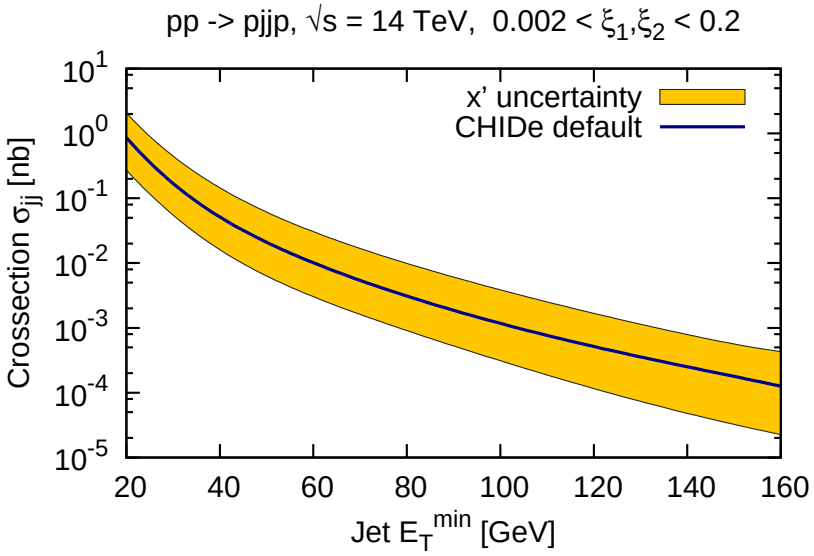


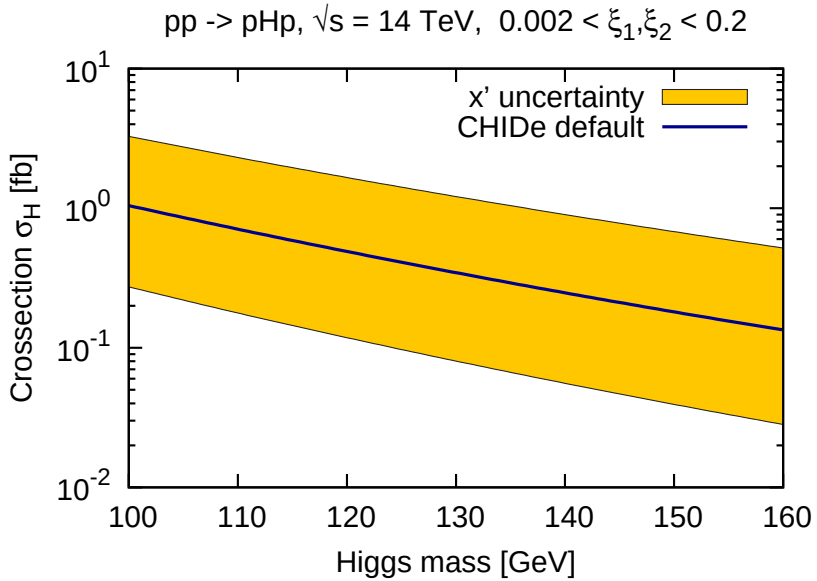
No upper limit ambiguity for Higgs ($\mu = M_H$)

Model uncertainties – Sudakov factor lower limit (x')

$$T(Q_T,\mu) = \exp\left\{ -\int_{Q_T^2/x'}^{\mu^2/x} \frac{\alpha_S(k_T^2)}{2\pi}\frac{\mathrm{d}k_T^2}{k_T^2} \int_0^{1-\Delta} \mathrm{d}z \left(zP_{gg}(z) + \sum_q P_{qg}(z) \right) \right\}$$

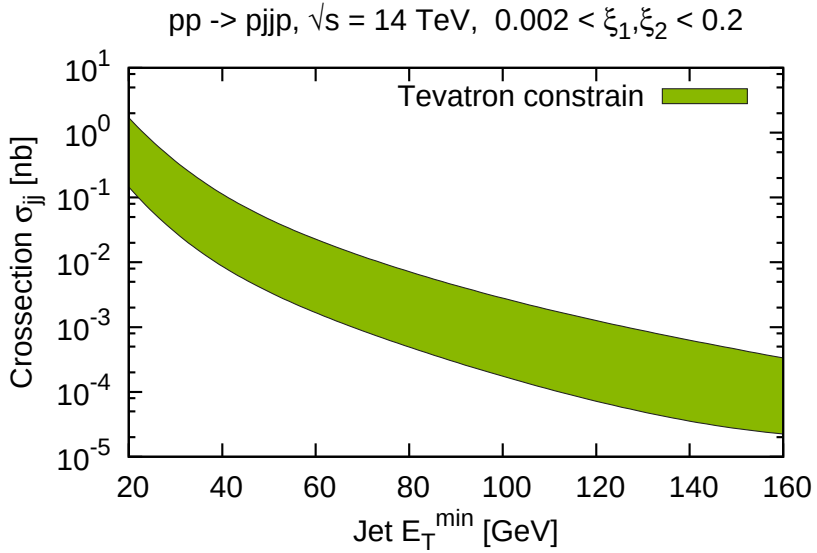


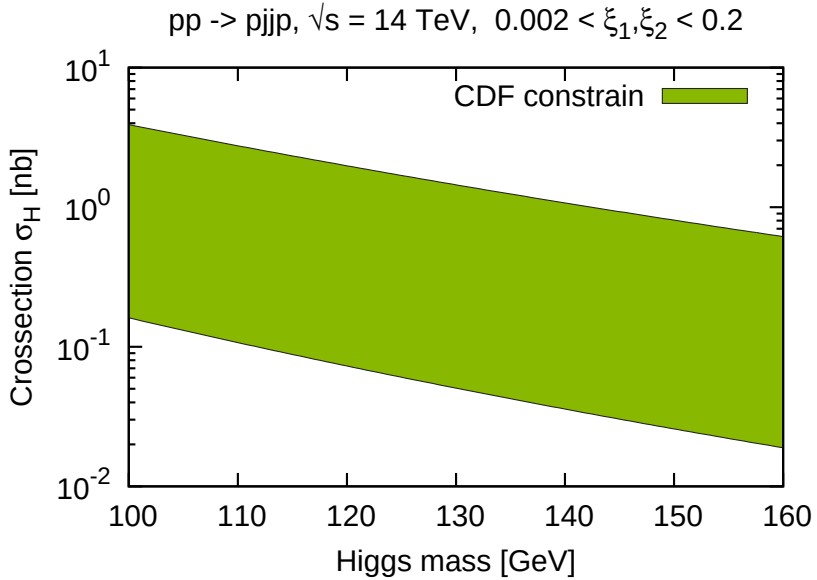




Model constraining from CDF measurements

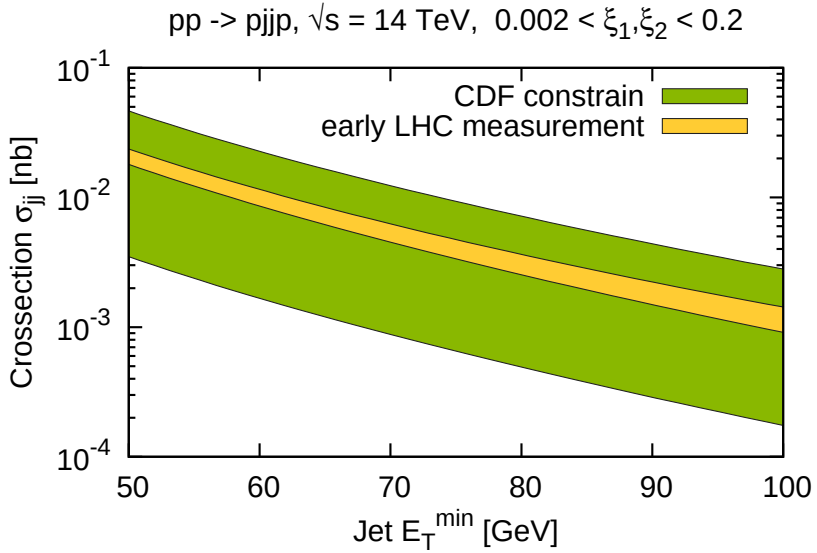
- **For each gluon distribution**
  choose a range of lower Sudakov limit (x'_{min} and x'_{max}) which agrees with CDF measurement (taking the uncertainty into account)
- **For each gluon distribution**
  use the same x' range to calculate uncertainty on LHC dijets and Higgs

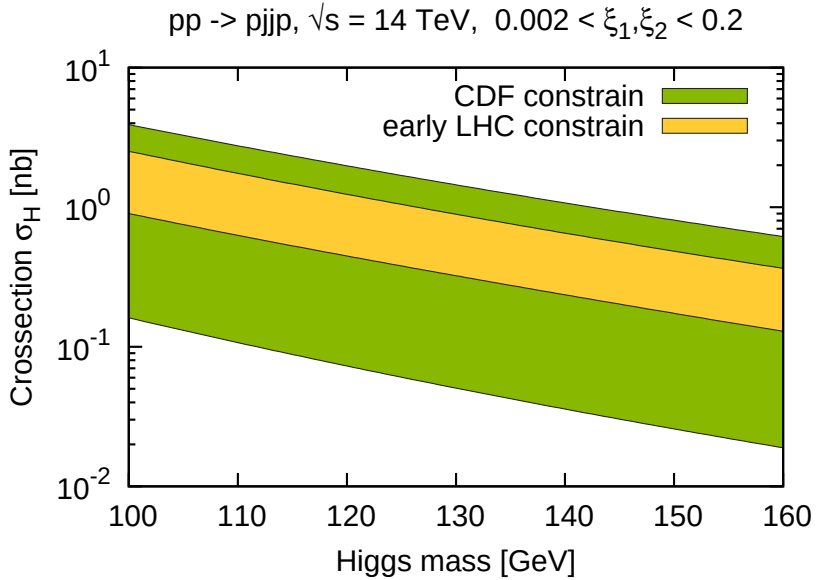




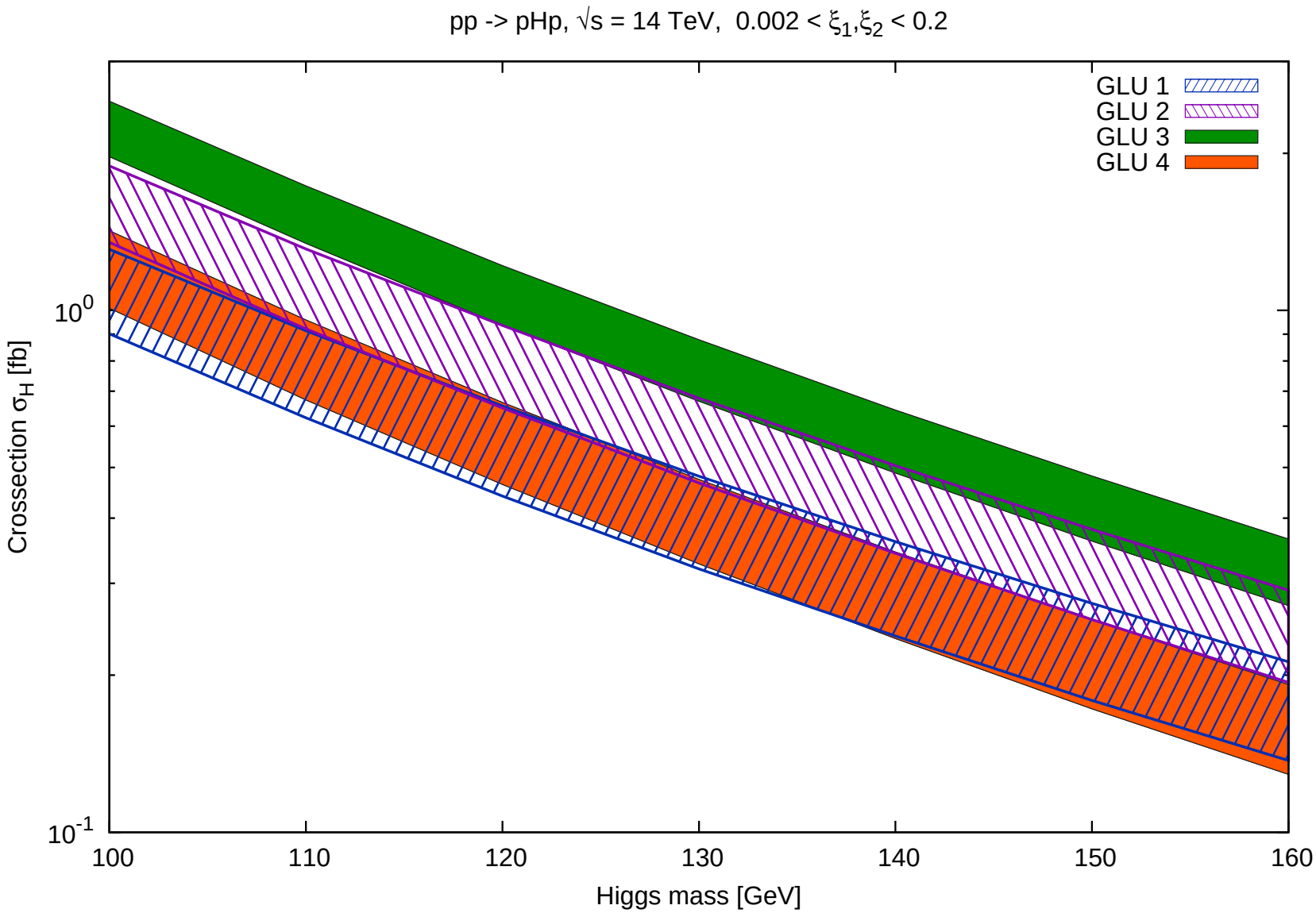
Model constraining from LHC measurements

- Assume LHC measurement of exclusive dijets:
  100 pb^{-1}
  3% jet energy scale
- **For each gluon distribution**
  choose a range of lower Sudakov limit which agrees with the measurement
- **For each gluon distribution**
  use the same range to calculate uncertainty on Higgs





Contributions to final Higgs uncertainty



Conclusions

1. FPMC is developing rapidly – quark jets, di-photons in CHIDe model and Krakow model this year
2. CHIDe & KMR – fine description of CDF dijet measurement
3. Uncertainties for Higgs production can be constrained by LHC measurements of exclusive dijets
4. Need for studies of other exclusive processes to constrain better the Higgs prediction